

REMARKS

Reconsideration of the present application is respectfully requested. Claims 3 and 6 are amended herein. It is submitted that the claims under consideration are in condition of allowance, particularly in view of the following remarks.

Claims 3-4, 6-7, 13-22, 33, 35-36, 39 and 41-45 remain rejected under 35 U.S.C. §103(a) based upon the combined teachings of Cadien et al. (U.S. 5,516,346) in view of Kaufman et al. (U.S. 6,063,306).

The examiner purports that Cadien et al. teaches a concave insulating film formed on a substrate forming a barrier layer, forming an interconnect metal film over the surface, polishing the surface by a first and second polishing process until the surface of the insulating film, other than the concave, is exposed. Also, the examiner purports that Cadien et al uses a polishing slurry comprising silica polishing material, an inorganic salt, and an oxidizing agent.

The examiner indicates Kaufman, et al. shows:

“applying a first slurry comprising an alkanolamine (such as, triethanolamine) and second slurry comprising carboxylic acid (such as tartaric acid) in a polishing process as well known in the art. Kaufman et al. also teaches the slurry comprising benzotriazole and the barrier film being a tantalum-containing metal film (Abstract, col. 4, lines 15-67, col. 6, lines 2-45, col. 8, lines 20-45, col. 10, lines 50-65, TABLE 1, 4, col. 15, lines 25-65, col. 16, lines 48-67).”

The applicants submit that the claimed subject matter as a whole is neither taught or suggested by the prior art references.

It is the applicants position that the examiner has not made out a prima facie case of nonpatentability based upon the combined teachings of Cadien et al. (U.S. 5,516,346) in view of Kaufman et al. (U.S. 6,063,306), specifically because the examiner ascribes unreasonably undue

breadth to the disclosure of Cadien et al. The examiner purports that “Cadien et al. also teaches the interconnect metal having films (306 and 308) and part of the interconnect metal remains on the surface other than the concave (Fig. 3b, col. 5, lines 1-40, col. 8, lines 16-60)”. This position, in the view of the applicants, is unsupported by the disclosure of Cadien et al. and further, what Cadien et al. **actually** suggests is completely at odds with what the examiner **purports** it suggests. Specifically, at col. 8., lines 16-20, Cadien et al. teaches, “*substantially all* of the tungsten layer 308 formed on the titanium nitride layer 305 formed over the top surface of the interlayer dielectric 302 is removed”. Thus, the person of ordinary skill in the art, apprised of this teaching of Cadien et al., would learn that the polishing step removes **substantially** all of the tungsten layer, it thereby being implicit that a mere insubstantial portion of the barrier layer remains. Cadien et al.'s teaching is in direct contrast to the teachings of the specification at page 13, where, with reference to Fig. 3(a), it is indicated that “CMP may be conducted in the first polishing step such that an interconnect metal film 25 *partially remains* on the surface other than the concave formed on the insulating film 24, *to partially leave* the interconnect metal film 25 in a sparse interconnect area and to stop polishing before the insulating film 23 between interconnects in the dense interconnect area is polished”. Accordingly the teachings of the present application are that, after polishing, the interconnect metal film 25 is partially left behind. See Specification at page 13, lines 1-18. This supports the present claim amendment that “the portion of the interconnect film remaining on the surface [after polishing is] not...insubstantial” Not only is there no suggestion in Cadien et al. to leave more than an insubstantial *portion* of the interconnect layer on the surface of the metal interconnect, it is evident that Cadien, et al., in

teaching removal of substantially all of the tungsten layer, is in fact teaching away from the present invention.

Claim 13 was previously amended to clarify the claimed subject matter, that is, that during the first polishing step, except for the concave portion, the interconnect metal film is substantially removed from the surface while the barrier metal film is not completely removed by polishing.

Accordingly, it is respectfully observed that:

1. Claims 3 and 6 distinguish over Kaufman, et al. in view of Cadien, et al. in that the portion of interconnect metal film remaining on the surface is not insubstantial;
2. There is teaching in Cadien, et al. that its polishing slurry is effective at polishing a substrate having a Ta-barrier layer;
3. Kaufman is deficient as to the time at which the first polishing step is terminated, whereas in claim 13 it is indicated that except for the concave portion, the interconnect metal film is substantially removed from the surface while the barrier metal film is not completely removed by polishing; and
4. The second slurry composition is not taught by the references. For this reason, it is respectfully submitted that the rejections are traversed.

It is observed that:

“To establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the

reasonable expectation of success must both be found in the prior art, and not based on the applicant's disclosure. *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991). See MPEP § 2143 - § 2143.03 for decisions pertinent to each of these criteria.

The initial burden is on the examiner to provide some suggestion of the desirability of doing what the inventor has done. To support the conclusion that the claimed invention is directed to obvious subject matter, either the references must expressly or impliedly suggest the claimed invention or the examiner must present a convincing line of reasoning as to why the artisan would have found the claimed invention to have been obvious in light of the teachings of the references." *Ex parte Clapp*, 227 USPQ 972, 973 (Bd. Pat. App. & Inter. 1985).

As indicated above, and as discussed in greater detail below, certain aspects of the invention as claimed are not taught or suggested by Kaufman, et al. in view of Cadien, et al.

Reason 1

After practicing the first polishing step recited in claims 3 and 6, the interconnect metal film (i.e., Cu-based film) partially on the surface in locations other than in the concave portion (see p. 12, line 9 – p. 15, line 24). On the contrary, Cadien et al. discloses that the first polishing step continues until substantially all of the W (tungsten) layer formed on TiN layer is removed (see column 8, lines 17-21).

Kaufman, et al. does not cure this deficiency. Kaufman, et al. does not disclose at what time the polishing step is terminated. For this first reason, it is submitted that claims 3, 6, and the claims, which depend from them, are in condition of allowance.

What is interesting is that the examiner seems to have misunderstood aspects of the applicants' arguments set forth in their previous response. The examiner indicates that

“applicant argued that, after practicing the first polishing step recited in claims 3 and 6, the interconnect metal film (i.e., Cu-based film) is partially on the surface in locations other than in the concave portion. Applicant argued that, on the

contrary Cadien et al. discloses that the first polishing step continues until substantially all tungsten layer formed on Tin layer is removed. However, claims 3 and 6 do not recite the interconnect metal being a copper-based film”.

The applicants must point out that it has never been their position that claims were patentable because the applicants applied an interconnect layer made of copper, contrary to the examiner’s responsive statement. The reference to copper was made solely for purposes of drawing the examiner’s attention to the location in the specification supporting the claim limitation directed to the first polishing step and leaving a portion of the interconnect metal film on the surface. Thus, whether the interconnect is copper is not the point.

Reason 2

Cadien et al. discloses a polishing slurry comprising an inorganic salt (fluoride salt) employed as a complexing agent to complex with the Ti in a Ti layer (see column 8, lines 53-56). However, in the present invention, Ta is used as a barrier metal, not Ti (see claims 39 and new claim 45). Cadien et al. does not teach that the slurry including the inorganic salt is effective at polishing a layered substrate employing a Ta layer as a barrier layer. For this reason, these claims are in condition of allowance.

Reason 3

As indicated above, Kaufman et al. does not disclose at what time the first polishing step is terminated. As recited in claim 13 of the present application, the first polishing step is conducted such that except for the concave portion, the interconnect metal film is substantially removed from the surface while the barrier metal film is not completely removed by polishing. Cadien, et al. does not cure this deficiency, as it teaches that the surface of the insulating film is exposed (see p.11, supra.). Furthermore, the second slurry used in the second polishing step of Kaufman, et al. has a polishing-rate ratio of the interconnect metal to the barrier metal of 1 or

less (see p. 16, line 1 – p. 17, line 23).

When the interconnect metal film remains on the surface other than in the concave portion after the first polishing step, complete removal of the remaining interconnect metal film in the second polishing step is difficult because the low polishing-rate ratio of the interconnect metal to the barrier metal of the second slurry. This may cause problems, such as short-circuit relating to an insufficiently polished part, reduction in throughput because the time period in which polishing is practiced must be longer for preventing the short-circuit, and erosion resulting in an area of already exposed barrier metal or insulating film that was exposed in the first polishing step, due to the longer polishing period. For these reasons, it is submitted that the rejection of claim 13, and the claims which depend from it, are traversed.

Reason 4

As recited in claims 3, 13 and those claims depending from them, the first slurry, which contains alkanolamine, which may reduce the polishing rate for the barrier metal film while increasing the difference in the polishing rate between the barrier metal film and the interconnect metal film in order to enhance the function of the barrier metal film as a polishing “stopper”. Thus, the interconnect metal film is completely removed without realizing the above noted problems.

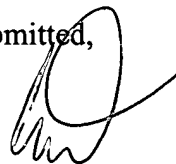
Since the barrier metal (Ta-based metal) is chemically much more stable than the interconnect metal (Cu-based metal), a polishing-rate ratio of the interconnect metal to the barrier metal of 1 or less has previously been achieved by reducing the contribution of chemical polishing; that is, by reducing the presence of an oxidizing agent or by adding an antioxidant to reduce a polishing rate for the interconnect metal film. In this technique, a polishing rate for the barrier metal film remains at a relatively low value and tends to produce an insufficiently

polished part, which may lead to short-circuiting. On the other hand, an increase in the polishing time for preventing this problem may lead to other problems, such as reduced throughput. Also, excessive strengthening of mechanical polishing may cause problems such as scratches or erosion in the polished surface. Hence, the second polishing step in the second polishing method employs a polishing slurry which can control a polishing-rate ratio of the interconnect metal to the barrier metal to a desired level by increasing the polishing rate for the barrier metal film. Thus, the composition according to claims 16-19 is suited for use as the second slurry (see p. 20, line 19 – p. 21, line 25) where an alkanolamine is employed in the first polishing slurry.

Accordingly, Kaufman et al. is deficient with respect to the time where the first polishing step is ceased in the method of claim 13, nor does it teach the second slurry composition of claims 16-19.

Based on the foregoing, it is respectfully submitted that all the claims of the present application contain patentable subject matter and a Notice of Allowance it respectfully requested.

Respectfully submitted,



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